



PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 39th cycle

**PNRR 118 INTERDISC Research Field: MICROMECHANICAL MODELS FOR ACTIVE
BIOLOGICAL TISSUES**

| |
|--|
| Monthly net income of PhDscholarship (max 36 months) |
| € 1195.5 |
| In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
|---|---|
| <p>Motivation and objectives of the research in this field</p> | <p>Sustainable Development Goal (as defined by United Nations) linked to this research: Good health and well-being.</p> <p>The aim of the study is to improve mechanical models of tissues for applications in cardiovascular and refractive surgery, as a first step towards the construction of digital twins, to be used to develop virtual experience before the actual surgery. Focus is in organs whose biological functions are dominated by the anatomical shape, that can be modified by strains with no associated stresses or stresses with no associated strains, as in the case of heart valves, cerebral vessels, lens of the eye, and others. The research is promoted by the obstacles encountered in surgical interventions related to individual biological variability. Constitutive models of the behavior of tissues, developed at a sufficiently sophisticated level, can help in predicting their response to random actions, typical of surgical operations. To attain a sufficiently high predictability, constitutive models must account for microstructures (micro- and nano-scale components, such as fibers, cells, filaments, and more), because only with a clear description of their geometry and function in the tissue it is possible, with one mathematical model, to predict the response to different stimuli. Although artificial intelligence, in particular machine learning based on big</p> |



| | |
|--|--|
| | <p>data, is a powerful tool for characterizing the behavior of a biological tissue, customization is imperative. In particular, for cases of refractive or vascular surgery that deviate from the average response in the specific patient, the required micrometric precision cannot ignore the microstructure of the tissue.</p> |
| <p>Methods and techniques that will be developed and used to carry out the research</p> | <p>Micro- and nano-scale structural modeling of active and passive constitutive models for biological tissues; numerical methods for systems of partial differential equations and numerical coupling of integrated problems; big data management; use of physics-based and data-driven methods for model discovery; machine learning algorithms. The training of the PhD student will develop within the Polimi institutional courses and participation to dedicated teaching programs offered by CISM or other international institutions.</p> |
| <p>Educational objectives</p> | <p>To educate a researcher able to understand the function of a tissue from the microstructure and to use the most advanced mathematical tools to address complex multi-physic problems.</p> |
| <p>Job opportunities</p> | <p>Employment in advanced biology or modelling research centers, university hospitals, health industry (producers of devices for heart, eye, prosthetic).</p> |
| <p>Composition of the research group</p> | <p>2 Full Professors 1 Associated Professors 1 Assistant Professors 1 PhD Students</p> |
| <p>Name of the research directors</p> | <p>Anna Marina Pandolfi and Luca Dedè</p> |

| Contacts |
|--|
| <p>anna.pandolfi@polimi.it phone: +39 0223994217 https://pandolfi.faculty.polimi.it</p> <p>luca.dede@polimi.it phone: +39 02-23994217 https://www.mate.polimi.it/pagina-personale/?id=551&lg=it#ann</p> |



| Additional support - Financial aid per PhD student per year (gross amount) | |
|--|----|
| Housing - Foreign Students | -- |
| Housing - Out-of-town residents (more than 80Km out of Milano) | -- |

| Scholarship Increase for a period abroad | |
|--|----------|
| Amount monthly | 597.75 € |
| By number of months | 6 |

| National Operational Program for Research and Innovation | |
|--|--|
| Company where the candidate will attend the stage (name and brief description) | / |
| By number of months at the company | 0 |
| Institution or company where the candidate will spend the period abroad (name and brief description) | School of Mathematics & Statistics of the University of Glasgow, department of Mathematics, SoftMech Group - http://www.softmech.org/ |
| By number of months abroad | 6 |

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research

University of Glasgow, UK
 EPFL, Lausanne, Switzerland
 LENS-European Laboratory for Non-Linear Spectroscopy, University of Florence, Italy
 University Campus Biomedico, Roma, Italy
 University of Chieti-Pescara, Italy

Educational activities

The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship

Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undergraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.

Computer availability

Each Ph.D. student has his/her own computer for individual use.

Desk availability

Each Ph.D. student has his/her own desk, cabinet and locker.